REMARKS

Applicants acknowledge the indication of the allowability of the subject matter of Claims 4-6, as set forth at page 4 of the Office Action. In particular, the latter claims would be allowable if rewritten in independent form. However, for the reasons set forth hereinafter, Applicants respectfully submit that Claims 4-6 are allowable in their present dependent form.

Claims 1-3 and 8-11 (Claim 7 having been cancelled) have been rejected under 35 U.S.C. § 102(b) as anticipated by Dundas et al (U.S. Patent No. 4,692,701). Nevertheless, as discussed in more detail below, Applicants respectfully submit that Claims 1-3 and 8-11 distinguish over Dundas et al, whether considered by itself, or in combination with other references.

The present invention is directed to a method for measuring stress or strain by detecting so-called "Barkhausen noise". Such noise is generated, for example, as each of the domains in a ferromagnetic material aligns itself with an externally applied magnetic field. As each domain switches its alignment in this manner, a small magnetic pulse is generated, which can be detected by a magnetic coil.

The present invention utilizes the Barkhausen noise effect to detect stress in a magnetizable element by applying a magnetic field to the element. In particular, the invention is based on a recognition of the fact that if a

continuously rising magnetizing current is used to generate a continuously rising magnetic field in an exciting coil, the magnetizing current which is present at the start of the Barkhausen noise is itself a measure of the tensile stress applied to the element (bolt 4), for example.

Accordingly, Claim 1 of the present application, which is representative, defines a method of measuring stress or strain in a magnetic or magnetizable element which includes arranging an exciting/sensing device adjacent to the element, and applying a continuously rising magnetizing current to the exciting device. In addition, Claim 1 further recites a step of "detecting starting of Barkhausen noise by means of the sensor device", and a further step of "determining the magnitude of the magnetizing current at the point when the Barkhausen noise starts". The latter magnitude is then compared with measured reference values to determine the stress / strain condition of the element.

Claim 8 is similarly limited in that it provides for detecting a time of commencement of Barkhausen noise in response to a continuously increasing magnetic field, with the strength of the magnetic field being determined at the time of commencement of the Barkhausen noise. The stress or strain in the item is then determined "as a function of the determined strength of the magnetic field" at the time when the Barkhausen noise commenced.

The Dundas et al reference is similar to the present invention in that it applies a magnetic field to an item such as a turbine rotor, and uses a detector coil 19 to detect the resulting pulses generated by the Barkhausen effect, as described previously, in order to detect "embrittlement" of the rotor.

However, the technique by which the pulses generated according to the Barkhausen effect are used for this purpose differs fundamentally from that of the present invention. That is, as discussed in the specification at Column 3, line 52 through Column 4, line 22, Barkhausen pulses generated by the detector coil 19, are amplified and passed through a highpass filter 23 to a pulse height analyzer 27, which produces a plot of the distribution of pulses by amplitude during a selected time interval. (See Column 3, lines 52-65.) Such a plot is illustrated, for example, in Figure 3, which shows the distribution of the number of pulses as a function of pulse height. This plot of pulse height distribution is then used to detect embrittlement of the rotor by comparing it with a corresponding distribution for a test sample of the rotor steel, or of the same rotor when it was installed (and therefore had not become brittle). In particular, as stated at Column 4, lines 8-10, "if a marked change in pulse height distribution or in the pulse time distribution is observed, this is indicate that the rotor has become embrittled".

To summarize, then, Dundas et al uses the "pulse time distribution of the Barkhausen burst" (Column 4, line 15), as illustrated in the bottom portion of

Figure 2 to generate a plot of the distribution of pulses by amplitude (that is, for each pulse height, the number of pulses with that pulse height which occur during the relevant time period) as illustrated in Figure 3, and the latter distribution is compared with corresponding pulse height distributions for non-degraded parts.

As can be seen from the foregoing brief description, the Dundas et al reference does not provide for a step of "detecting starting of Barkhausen noise" or of "determining magnitude of the magnetizing current when the Barkhausen noise starts". Moreover, it also does not contain or suggest a step of "comparing [the determined magnetizing current magnitude] with measured reference values to determine the stress / strain condition of the element" being examined. In fact, Dundas et al does not detect the start of Barkhausen noise, nor does it measures the magnetizing current at the time of the start of Barkhausen noise. It follows, of course, that it also does not compare any such magnetizing current with reference values.

In regard to the latter observations, Applicants note that the Office Action indicates at the bottom of page 2 that Dundas et al determines the magnitude of the magnetizing current when the Barkhausen noise starts, referring to Figures 3-5. Figures 3 and 4, however, are unrelated to the magnetizing current at the time when Barkhausen noise begins. Rather, they are, as noted previously, respective pulse height distribution graphs for a "new" element (Figure 3), and

for a degraded element (Figure 4). Figure 5, on the other hand, shows the time sequence of Barkhausen pulses for a degraded element, which corresponds to the graphic depiction in Figure 2 for a non-degraded element. In both Figures 2 and 5, the variable along the abscissa is time. None of Figures 3-5 teaches or suggests that the magnitude of the magnetizing current at the time when Barkhausen noise commences is determined or used for any purpose. Indeed, insofar as Applicants have been able to determine, Dundas et al contains no provision for measuring magnetizing current at all. Nor is any value of magnetizing current used for comparison purposes to determine the degree of stress or strain in an object, the only comparison being between the graphic display of pulse height distribution in Figure 3 with that of Figure 4, a technique which is fundamentally different from that of the present application.

With regard to Claim 2, the Office Action refers to Figure 1 to support the proposition that in Dundas et al the sensing device at least partially surrounds the element. However, the element itself does not appear in Figure 1, nor is there any discussion in the specification, which teaches or suggests that the sensing device partially surrounds the element as claimed. Accordingly, Applicants respectfully submit that Claim 2 distinguishes over Dundas et al for this additional reason as well.

In light of the foregoing remarks, this application should be in condition for allowance, and early passage of this case to issue is respectfully requested. If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #056226.55708US).

Respectfully submitted,

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